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(19)(CA) **APPLICATION FOR CANADIAN PATENT** (12)

(54) Near Field Antenna Measurement Systems and Methods

(72) Lopez, Alfred R. - U.S.A. ;
Feldman, Paul H. - U.S.A. ;
Gencorelli, Joseph B. - U.S.A. ;
Schay, Gary - U.S.A. ;

(73) Hazeltine Corporation - U.S.A. ;

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(57) 28 Claims

WE CLAIM:

1. An antenna measurement system providing phase conjugate processing of near field signals for evaluating antenna performance, comprising:

coupling means for coupling signals;

antenna means, for coupling radiated signals, comprising an antenna element configured for use in the near field region of an antenna to be measured; and

signal translation means, coupled to said coupling means and antenna means, for supporting said antenna means in said near field region at a position on a reference axis intersecting an antenna test position and for proportioning at least one characteristic of signal components representative of off-axis signal samples, relative to signal components representative of on-axis signal samples, so as to translate between near field type radiated signals at said antenna means and focused pattern representative signals at said coupling means;

whereby, near field signal translation, utilizing relative signal component characteristic proportioning of off-axis versus on-axis signal information, enables effective antenna pattern evaluation based on near field signals.

2. An antenna measurement system as in claim 1, additionally comprising a signal source, coupled to said coupling means, for providing input signals, whereby said system is effective to operate as a plane wave source radiating signals in the near field region which approximate a plane wave when received by an antenna under test.

3. An antenna measurement system as in claim 1, additionally comprising a monitor, coupled to said coupling means, for providing a visual representation of a characteristic of an antenna pattern radiated by an antenna under test, whereby said system is effective to translate near field signals from an antenna under test into signals coupled to said monitor in the form of a focused representation of the received near field signals.

4. An antenna measurement system as in claim 1 or 3, wherein said antenna means includes a single antenna element, said system is configured for evaluation based on monitoring of an antenna beam scanned across said element and said signal translation means comprises signal processor means providing time based processing and weighting of signal components selected as said beam sweeps across said element.

5. An antenna measurement system as in claim 1, 2 or 3, wherein said antenna means comprises a plurality of antenna elements spaced from each other so as to sample on-axis and off-axis signal components which are coupled with relative differences in phase and amplitude.

6. An antenna measurement system providing phase conjugate processing of near field signals for evaluating antenna performance, comprising:

coupling means for coupling signals;

antenna means, for coupling radiated signals, comprising a plurality of antenna elements configured for use in the near field region of an antenna to be measured; and

signal translation means, coupled to said coupling means and antenna means, for supporting a first antenna element at a position on a reference axis intersecting an antenna test position, for supporting the remaining elements at positions spaced from said axis and for coupling said first element and said remaining elements to said coupling means with relative differences in phase and in signal transmission values;

whereby, signal components representative of off-axis beam signal samples coupled to said remaining elements are proportioned in phase by said signal translation means and in amplitude as a result of said transmission value difference, relative to signal components representative of on-axis beam signal samples coupled to said first antenna element.

7. An antenna measurement system as in claim 6, additionally comprising a signal source, coupled to said coupling means, for providing input signals, whereby said system is effective to operate as a plane wave source radiating signals in the near field region which approximate a plane wave when received by an antenna under test.

8. An antenna measurement system as in claim 6, additionally comprising a monitor, coupled to said coupling means, for providing a visual representation of a characteristic of an antenna pattern radiated by an antenna under test, whereby said system is effective to translate near field signals from an antenna under test into signals coupled

to said monitor in the form of a focused representation of the received near field signals.

9. An antenna measurement system as in claim 6, 7 or 8, wherein said signal translation means supports said remaining elements in alignment with a plane intersecting said axis at a displacement from said first element, said displacement introducing a difference in phase of signal components representative of off-axis signal samples coupled to said remaining elements, relative to on-axis signal samples coupled to said first antenna element.

10. An antenna measurement system as in claim 6, 7 or 8, wherein said signal transmission means couples said remaining elements to said coupling means via transmission paths of length different than the path coupling said first element, said difference in transmission path lengths introducing a difference in phase of signal components representative of off-axis signal samples coupled to said remaining elements, relative to signal components representative of on-axis signal samples coupled to said first antenna element.

11. An antenna measurement system as in claim 6, 7 or 8, wherein said signal transmission means couples said remaining elements to said coupling means via transmission paths providing increased attenuation relative to the transmission path coupling said first element.

12. An antenna measurement system providing phase conjugate processing of near field signals for evaluating antenna performance, comprising:

coupling means for coupling signals;

antenna means, for coupling radiated signals, comprising five antenna elements configured for use in the near field region of an antenna to be measured; and

signal translation means, coupled to said coupling means and antenna means, for supporting a first antenna element at a position on a reference axis intersecting an antenna test position, for supporting the remaining four of said elements at positions spaced from said axis in alignment with a plane intersecting said axis at a displacement from said first element, and for coupling said first element and said four elements to said coupling means with a relative difference in signal transmission values;

whereby, signal components representative of off-axis beam signal samples coupled to said remaining elements are proportioned in phase as a result of said displacement and in amplitude as a result of said transmission value difference, relative to signal components representative of on-axis beam signal samples coupled to said first antenna element.

13. An antenna measurement system providing phase conjugate processing of near field signals for evaluating scanned beam array antennas, comprising:

coupling means for coupling signals;

antenna means for coupling radiated signals, comprising at least three antenna elements configured for use

in the near field region of an array antenna adapted for scanning a beam; and

signal translation means, coupled to said terminal and antenna means, for supporting a first antenna element at a position on a reference axis intersecting an antenna test position, for supporting the remaining elements in spaced relationship from said axis along a line intersecting said axis at a displacement from said first element, and for coupling said first element and said remaining elements to said coupling means with a relative difference in signal transmission values;

whereby signal components representative of off-axis beam signal samples coupled to said remaining elements are proportioned in phase as a result of said displacement and in amplitude as a result of said transmission value difference, relative to signal components representative of on-axis beam signal samples coupled to the first element, so as to translate between near field type radiated signals at said antenna means and plane wave representative signals at said coupling means.

14. An antenna measurement system as in claim 13, additionally comprising a monitor, coupled to said coupling means, for providing a visual representation of a characteristic of an antenna pattern radiated by a scanned beam array antenna under test, whereby said system is effective to translate near field signals from an antenna under test into signals coupled to said monitor in the form of a far field representation of the received near field signals.

15. An antenna measurement system providing phase conjugate processing of near field signals, for evaluating scanned beam array antennas, comprising:

coupling means for coupling signals;

antenna means for coupling radiated signals, comprising a single antenna element configured for use in the near field region of an array antenna adapted for scanning a beam; and

signal translation means, coupled to said terminal and antenna means, comprising signal processing means for selecting a plurality of components of a scanned beam signal received by said antenna element, for processing and weighting signal components representative of off-axis signal samples relative to signal components representative of on-axis signal samples, and for combining said components so as to translate between near field type radiated signals at said element and focused pattern representative signals at said coupling means;

whereby, near field translation, utilizing appropriate amplitude and phase variation proportioning of off-axis versus on-axis signal information, enables effective antenna pattern evaluation with near field monitoring of radiated signals.

16. An antenna measurement system as in claim 15, wherein said signal processing means comprises means for separating received signals into I and Q components which are processed, weighted and combined in providing said focused pattern representative signals.

17. An antenna measurement system as in claim 15 or 16, additionally comprising a monitor, coupled to said coupling means, for providing a visual representation of a characteristic of an antenna pattern radiated by a scanned beam array antenna under test, whereby said system is effective to translate near field signals from an antenna under test into signals coupled to said monitor in the form of a far field representation of the received near field signals.

18. An antenna test range, utilizing phase conjugate processing of near field signals for evaluating antenna performance, comprising:

coupling means for coupling signals;

a signal source coupled to said coupling means;

antenna means, for coupling radiated signals, comprising a plurality of antenna elements configured for use in the near field region of an antenna to be measured;

signal translation means, coupled to said coupling means and antenna means, for supporting a first antenna element at a position on a reference axis intersecting an antenna test position, for supporting the remaining elements at positions spaced from said axis and for coupling said first element and said remaining elements to said coupling means with relative differences in phase and in signal transmission values; and

support means, for supporting an antenna to be tested, positioned on said axis so as to support an antenna

under test at a position approximately one-quarter of the far field distance from said antenna elements;

whereby, signals provided by said signal source are radiated toward an antenna under test so as to approximate a plane wave when received by such antenna after travelling a radiated distance of the order of one-quarter of the far field distance.

19. An antenna test range as in claim 18, wherein said antenna means includes five antenna elements and said signal translation means supports said remaining four elements in an array transversely spaced from said first element.

20. An antenna test range as in claim 18, wherein: said antenna means includes thirteen elements; said signal translation means supports four of said elements in a first array transversely spaced from said first element and supports the remaining eight elements in a second array transversely spaced from said first array; and said support means is positioned to support an antenna under test at a position approximately one-eighth of the far field distance from said antenna elements; whereby the required radiated distance is of the order of one-eighth of the far field distance.

21. An antenna test range as in claim 19 or 20, wherein said array of four elements is spaced from said first element both along said axis and transversely to said axis.

22. An antenna test range as in claim 20, wherein said array of eight elements is spaced from said array of four elements both along said axis and transversely to said axis.

23. An antenna test range as in claim 19, wherein the transverse dimension of said array of four elements is approximately one-half of the largest dimension of an antenna to be tested measured transversely to said axis.

24. An antenna test range as in claim 20, wherein the transverse dimension of said array of eight elements is approximately equal to the largest dimension of an antenna to be tested measured transversely to said axis.

25. An antenna test range as in claim 19, 20, 23 or 24, additionally comprising an enclosure housing said antenna elements and antenna support means, so as to provide a test range with both security and freedom from spurious signal and atmospheric disruption.

26. An antenna test range as in claim 19, 20, 23 or 24, additionally comprising an enclosure housing said antenna elements and antenna support means, and means for absorbing radiated energy mounted on internal surfaces of said enclosure, so as to provide a test range with both security and freedom from spurious signal and atmospheric disruption.

27. A method of providing a substantially plane wave for antenna measurement purposes, comprising the step of:

positioning along a reference axis intersecting an antenna test position an on-axis antenna element and a plurality of off-axis antenna elements at a location within the near field region of an antenna to be tested;

providing signals to be radiated by said elements; and

translating such signals to said off-axis elements with phase and amplitude differences, relative to signals provided to said on-axis element, representative of appropriate proportioning of off-axis versus on-axis characteristics to provide a near field radiated signal which approximates a plane wave signal when received by an antenna under test.

28. A method of onitoring in the near field the performance of an antenna, comprising the steps of:

positioning along a reference axis intersecting an antenna test position an on-axis antenna element and a plurality of off-axis antenna elements at a location within the near field region of an antenna under test;

receiving, via said elements, signals radiated by said antenna under test;

translating such signals from said off-axis elements with phase and amplitude differences, relative to signals from said on-axis element, representative of

appropriate proportioning of off-axis versus on-axis characteristics to provide a resultant received signal in the form of a focused representation of the received near field signals; and

monitoring at least one characteristic of said resultant signal.

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ABSTRACT OF THE DISCLOSURE

A field monitor in the near field receives an antenna signal which approximates that which would be received by the monitor if located in the far field. In one aspect of the invention, the antenna signal is produced by an array of spaced apart receiving elements. In another aspect of the invention, the signal received from a near field sampling antenna is passed through a signal processor having the necessary characteristics to construct from the sample a signal corresponding to that which would have been received in the far field. Antenna element arrays are also used as plane wave sources permitting antenna testing with a radiating path length of one-eighth or one-quarter of the far field distance. Compact indoor antenna test ranges are also provided.

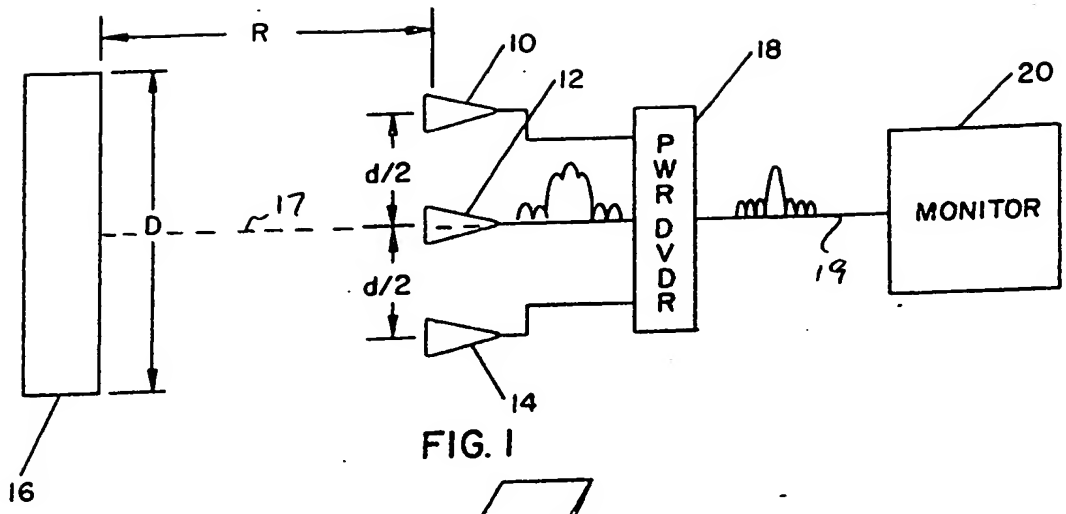
R
10
12
18
20
d/2
17
D
d/2
PWR DVDR
MONITOR
19
14
16

FIG. 1

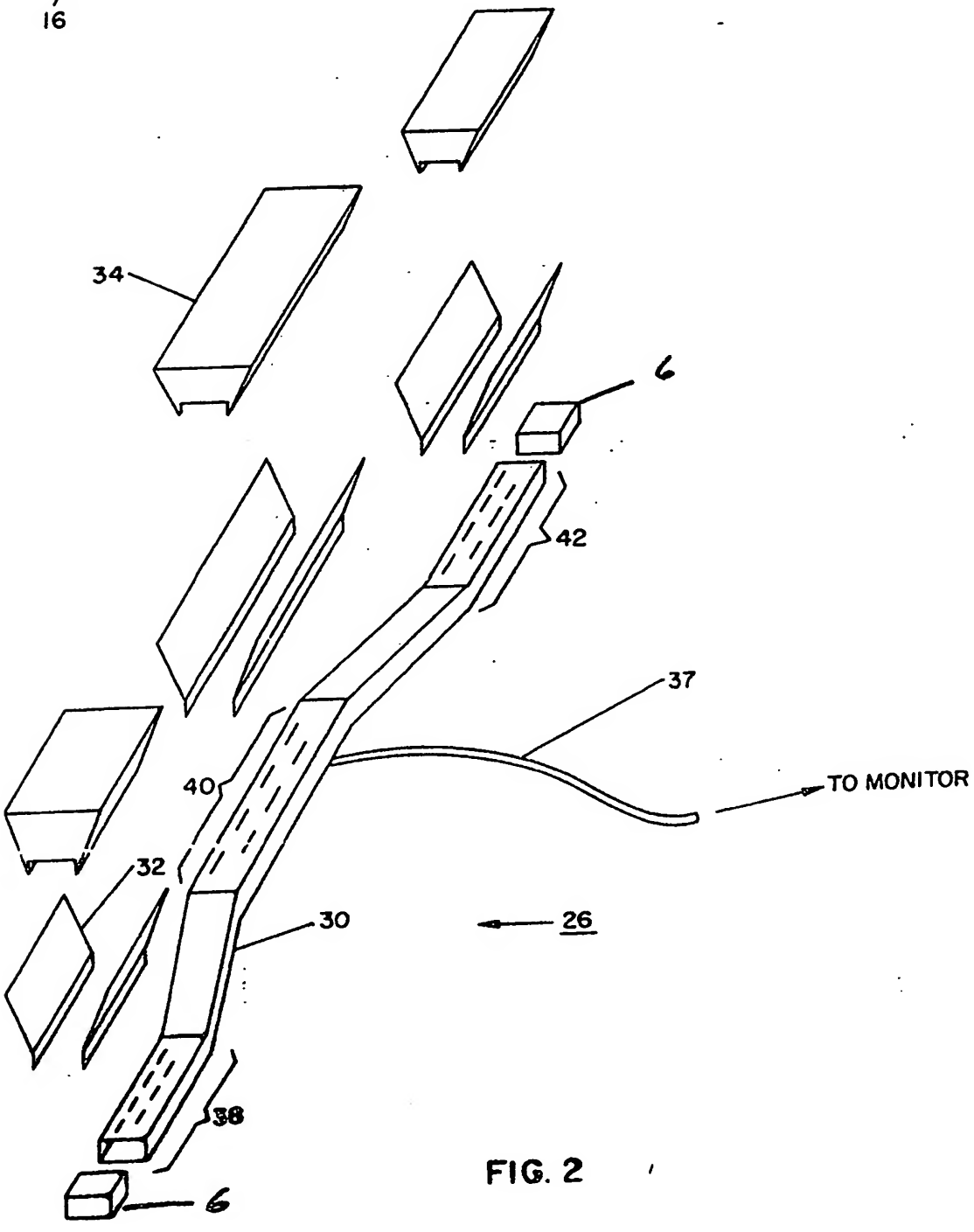
34
6
42
37
TO MONITOR
40
32
30
26
38
6

FIG. 2

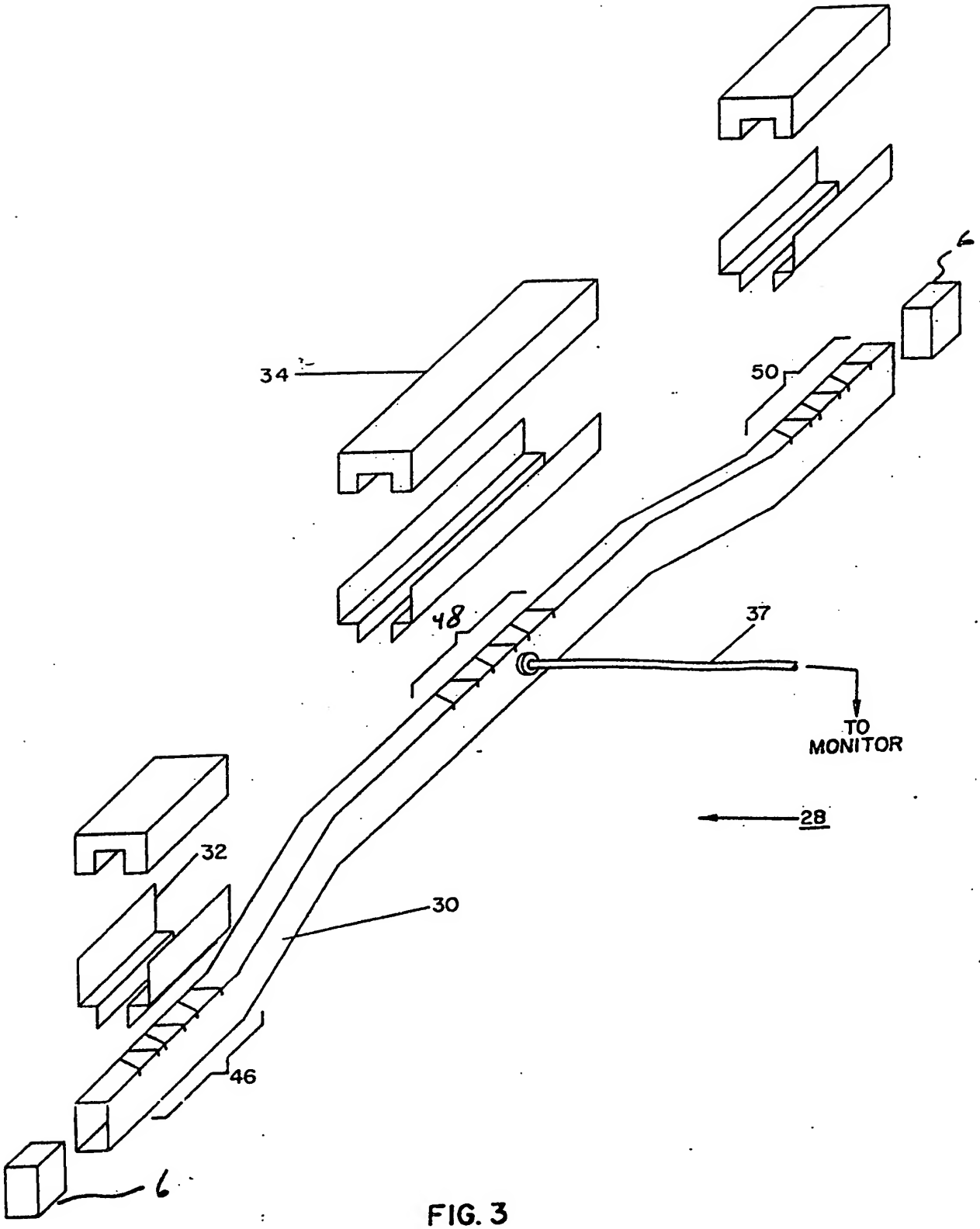

FIG. 3

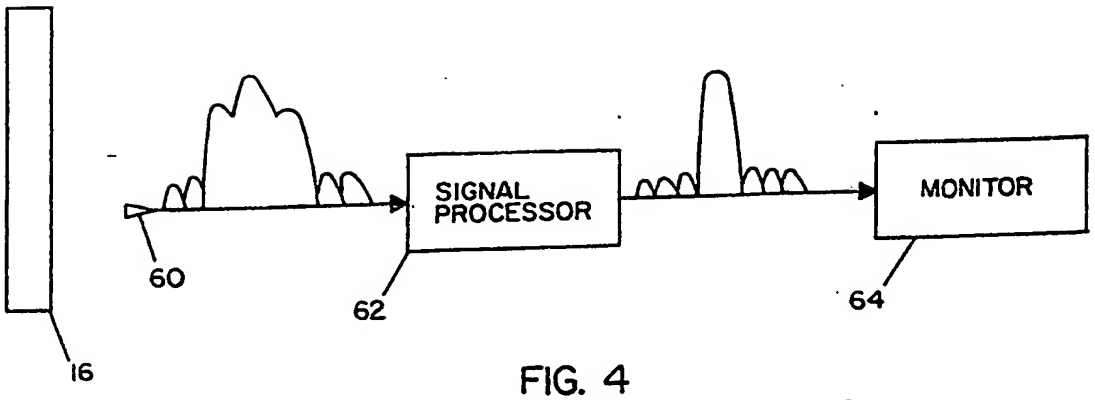

FIG. 4

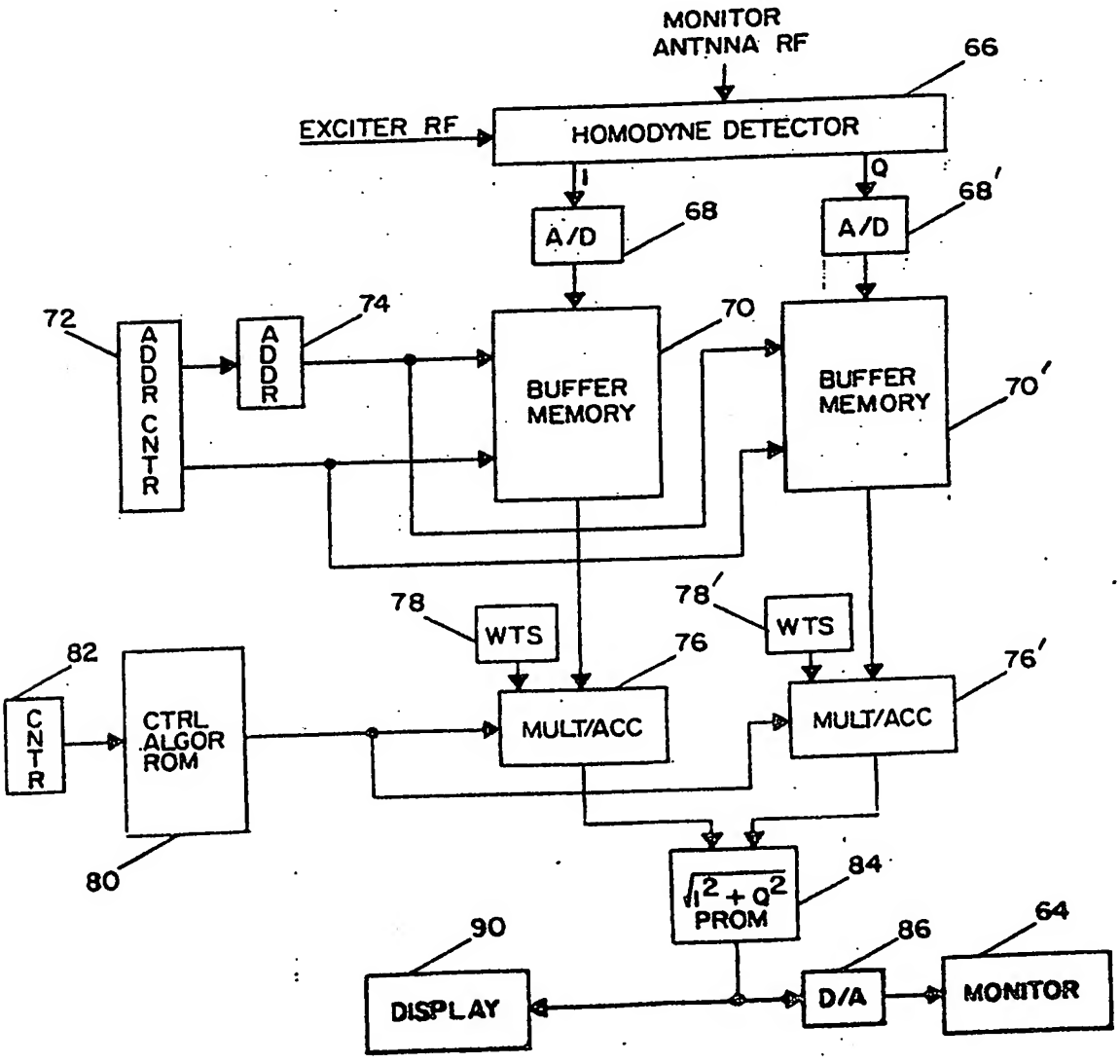

FIG. 5

NOTE - ADD PRIMES AS SHOWN

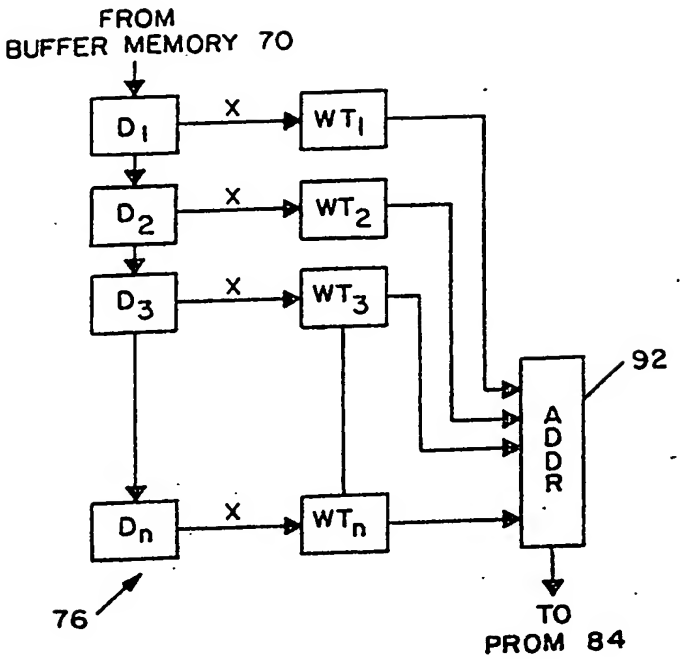
FROM
BUFFER MEMORY 70
D1
D2
D3
Dn
X
WT1
WT2
WT3
WTn
ADDR
92
76
TO
PROM 84

FIG. 6

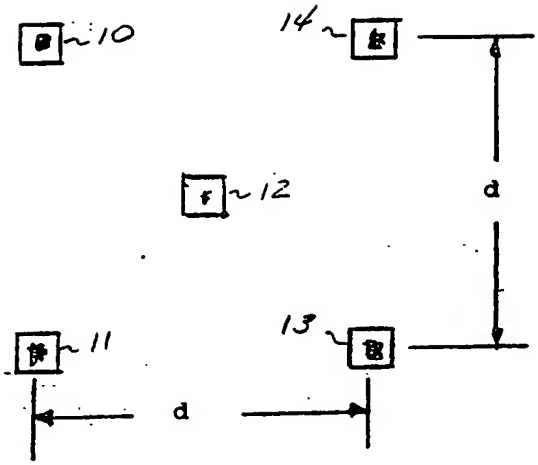

FIG 7(a)

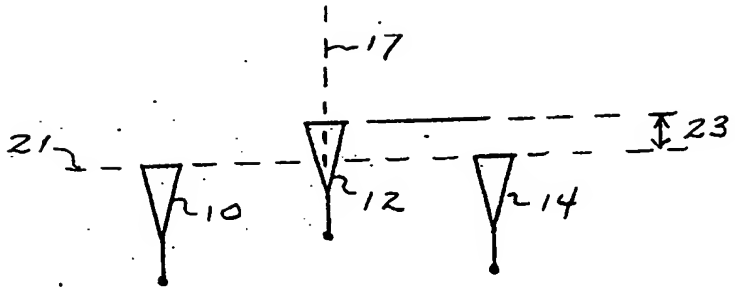

FIG 7(b)

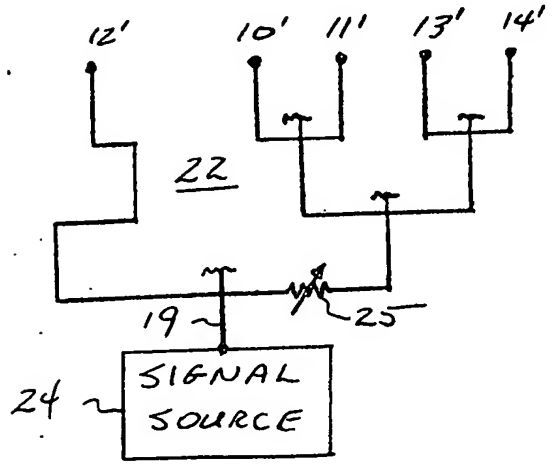

FIG 7(c)

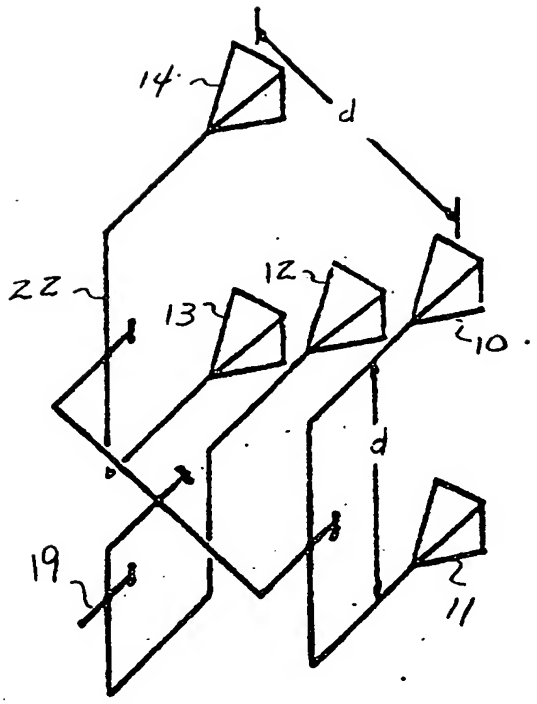

FIG 8

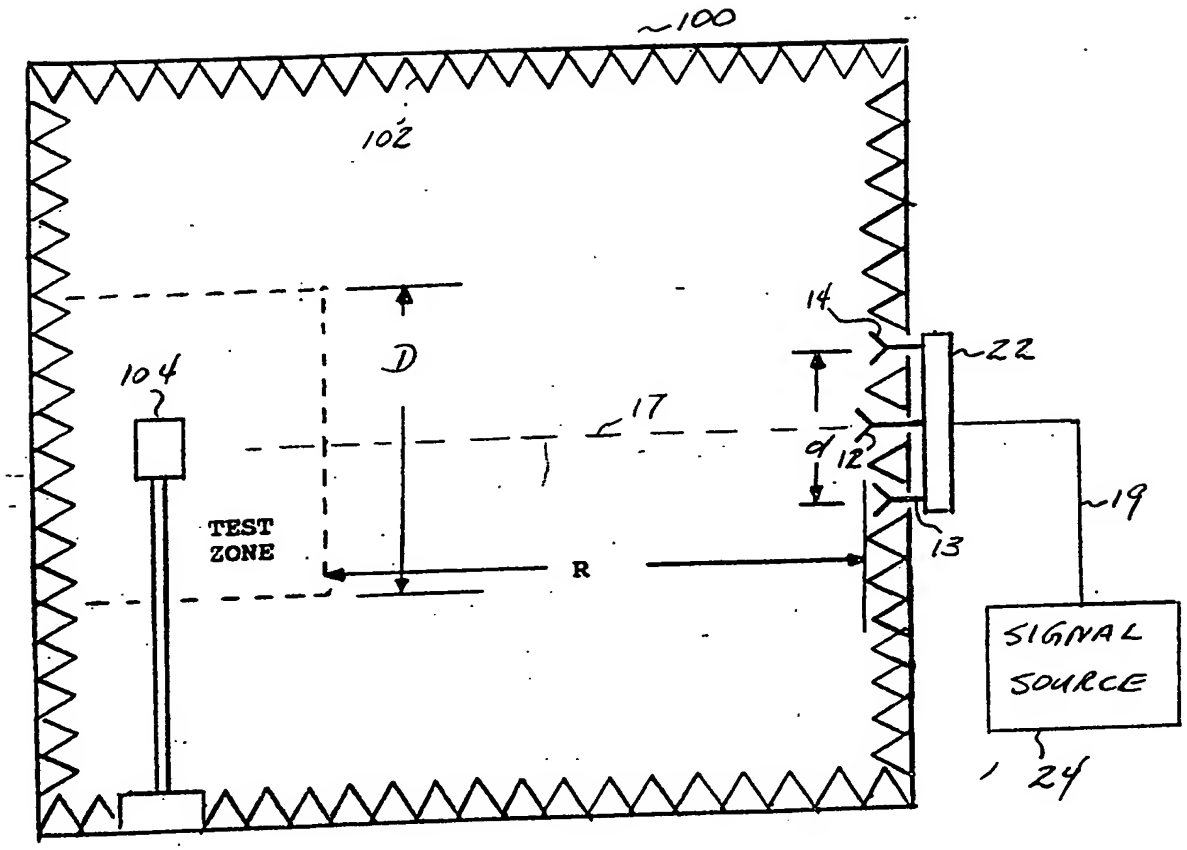

FIG. 9

~~Figure 4. Small chamber antenna range~~

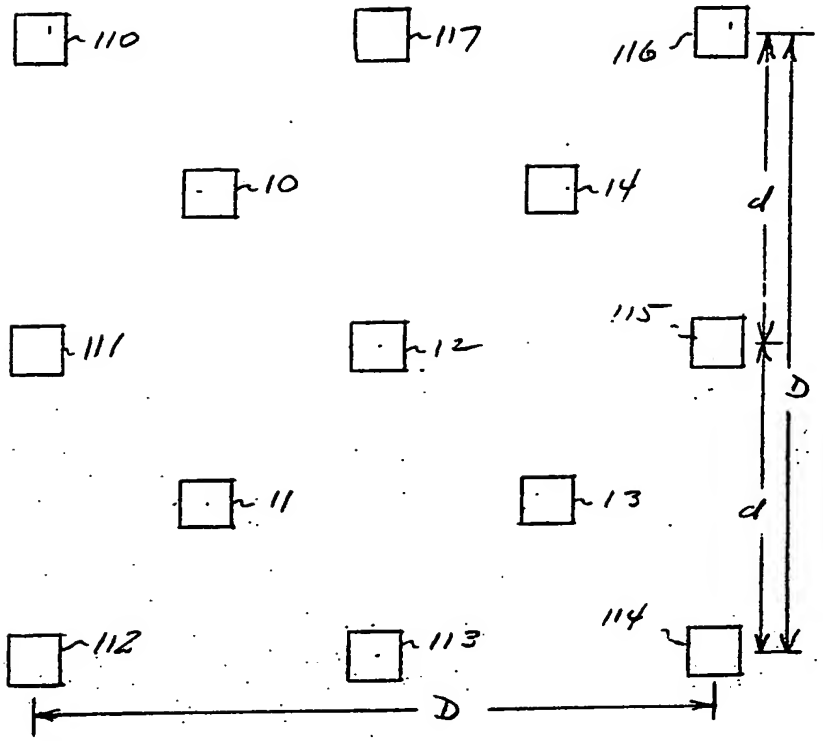

FIG 10(a)

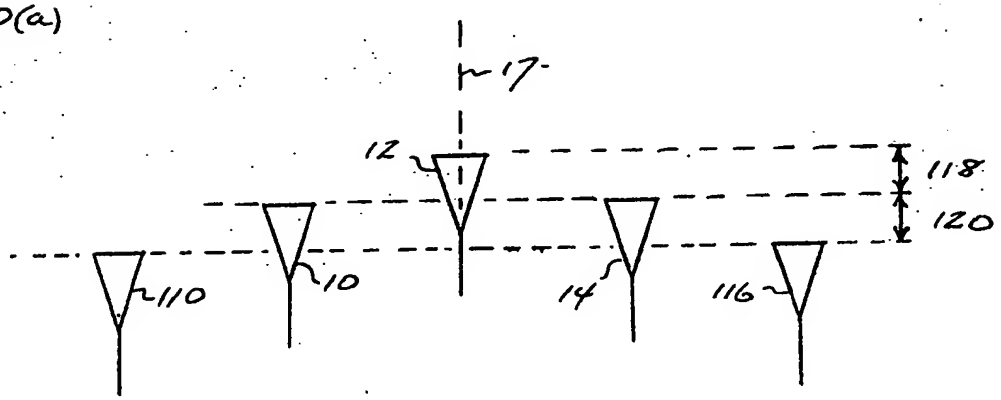

FIG 10(b).